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AUTHORITY
AFFDL ltr 29 Dec 1971

AFFDL-TR-66-43
PART XIII

AIRCRAFT GROUND-FLOTATION INVESTIGATION

PART XIII. DATA REPORT ON TEST SECTION 13

J. WATKINS and G. HAMMITT, II,

U. S. ARMY ENGINEER WATERWAYS EXPERIMENT STATION

TECHNICAL REPORT AFFDL-TR-66-43, PART XIII

OCTOBER 1966

AIR FORCE FLIGHT DYNAMICS LABORATORY
RESEARCH AND TECHNOLOGY DIVISION
AIR FORCE SYSTEMS COMMAND
WRIGHT-PATTERSON AIR FORCE BASE, OHIO

NOTICES

200 - January 1967 - C0192-16-301

AFFDL-TR-66-43
PART XIII

AIRCRAFT GROUND-FLOTATION INVESTIGATION

PART XIII. DATA REPORT ON TEST SECTION 13

J. WATKINS and G. HAMMITT, II,

FOREWORD

The investigation described herein constitutes one phase of studies conducted during 1964 and 1965 at the U. S. Army Engineer Waterways Experiment Station (WES) under U. S. Air Force Project No. 410-A, MIPR No. AS-4-177, "Development of Landing Gear Design Criteria for the CX-HLS Aircraft." (The CX-HLS is now designated C-5A.) This program was sponsored and directed by the Landing Gear Group, Air Force Flight Dynamics Laboratory, Research and Technology Division, Mr. R. J. Parker, Project Engineer.

These tests were conducted by personnel of the WES Flexible Pavement Branch, Soils Division, under the general supervision of Messrs. W. J. Turnbull, A. A. Maxwell, and R. G. Ahlvin, and the direct supervision of Mr. D. N. Brown. Other personnel actively engaged in this study were Messrs. C. D. Burns, D. M. Ladd, J. E. Watkins, H. H. Ulery, Jr., W. J. Hill, Jr., and G. M. Hammitt II. This report was prepared by Messrs. Watkins and Hammitt.

Directors of WES during the conduct of this investigation and preparation of this report were Col. Alex G. Sutton, Jr., CE, and Col. John R. Oswalt, Jr., CE. Technical Director was Mr. J. B. Tiffany.

Publication of this technical documentary report does not constitute Air Force approval of the report's findings or conclusions. It is published only for the exchange and stimulation of ideas.

AIVARS V. PETERSONS
Actg Chief, Mechanical Branch
Vehicle Equipment Division
AF Flight Dynamics Laboratory

ABSTRACT

The work presented in this data report was undertaken as part of an overall program to develop ground-flotation criteria for the C-5A aircraft. A test section was constructed to a width adequate for two test lanes. Each lane was divided into three items having different subgrade CBR values and different traffic surfaces. Item 1 was surfaced with modified T11 aluminum landing mat, item 2 with M8 steel landing mat, and item 3 remained unsurfaced. Traffic was applied to both lanes using a 70,000-lb test load on a twin-wheel tracking assembly consisting of two 25.00x28, 30-ply aircraft tires inflated to 50 psi. On one lane the wheels were spaced 58.5 in. c-c and on the other lane wheel spacing was 29.5 in. c-c.

The information reported herein includes layout of the test lanes, characteristics and print dimensions of the load assembly tires, and data collected on soil strengths, surface deformations and deflections, and drawbar pull. The traffic-coverage level is given at which each test item was considered failed.

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SUMMARY

Test Section 13 is one phase of a comprehensive research program to develop ground-flotation criteria for heavy cargo-type aircraft. Section 13 consisted of two similar traffic lanes, lanes 28 and 29, each of which was divided into three items (figure 15). Each item was constructed to a different subgrade CBR value and had a different traffic surface. Item 1 was surfaced with modified T11 aluminum landing mat, item 2 with M8 steel landing mat, and item 3 remained unsurfaced.

Traffic was applied to both lanes using a 70,000-lb test load on a twin-wheel tracking assembly consisting of two 25.00x28, 30-ply aircraft tires inflated to 50 psi. On lane 28 the wheels were spaced 58.5 in. c-c and on lane 29 the wheel spacing was 29.5 in. c-c.

The lanes in Test Section 13 were trafficked to failure in accordance with the criteria designated in Part I of this report. Data were recorded throughout testing to give a behavior history of each item. Using the test criteria mentioned above, it was possible to directly compare the effects of trafficking with a twin-wheel assembly using different wheel spacings. Basic performance data are summarized in the following paragraphs.

Lane 28

Item 1

The item was considered failed due to elastic deflection at 700 coverages. The rated CBR was 2.1.

Item 2

The item was considered failed due to roughness at 700 coverages. The rated CBR was 2.8.

Item 3

The item was considered failed due to roughness at 200 coverages. The rated CBR was 4.7.

Lane 29

Item 1

The item was considered failed due to roughness at 140 coverages. The rated CBR was 1.8.

Item 2

The item was considered failed due to roughness at 200 coverages. The rated CBR was 2.8.

Item 3

The item was considered failed due to roughness at 200 coverages. The rated CBR was 4.5.

AIRCRAFT GROUND-FLOTATION INVESTIGATION

PART XIII DATA REPORT ON TEST SECTION 13

SECTION I: INTRODUCTION

The investigation reported herein is one phase of a comprehensive research program being conducted at the U. S. Army Engineer Waterways Experiment Station (WES), Vicksburg, Miss., as part of U. S. Air Force Project No. 410-A, MIPR No. AS-4-177, to develop ground-flotation criteria for the C-5A, a heavy cargo-type aircraft. Specifically, the tests reported herein were conducted to determine the effect of wheel spacing of twin-wheel landing-gear assemblies on landing mat and unsurfaced soils under similar conditions of loading.

Prosecution of this investigation consisted of constructing two similar traffic lanes and subjecting them to equal test loads with twin-wheel landing-gear assemblies using different wheel spacings for the two lanes. This report presents a description of the test section and wheel assemblies, and gives results of traffic. Equipment used, types of data and method of recording them, and general test criteria are summarized herein; more complete explanations and illustrations appear in Part I of this report.

SECTION II: DESCRIPTION OF TEST SECTION AND LOAD VEHICLE

Description of Test Section

Test Section 13 (figure 15) was constructed within a roofed area in order to allow control of the subgrade CBR (California Bearing Ratio) in the test items. Section 13 was located on the same site as prior Test Sections 1, 3, and 5 in this series, the original construction of which is described in Part II of this report. The underlying subgrade was undisturbed by prior tests on the site so that in construction of Section 13 only the upper 24 in. of soil was excavated. The excavated area was backfilled to the original grade level in four compacted lifts with a heavy clay soil (buckshot; classified as CH according to the Unified Soil Classification System, MIL-STD-619). The fill material used was a local clay with a plastic limit of 27, liquid limit of 58, and plasticity index of 31. Gradation and classification data for the subgrade material are given in Part I.

Two traffic lanes, each divided into three items, were constructed in the test section. Different subgrade strengths were obtained in the items (figure 15) by controlling the water content and compaction effort. Items 1 and 2 were surfaced with modified T11 aluminum landing mat and M8 steel landing mat, respectively (figure 16), and item 3 remained unsurfaced. The landing mats used are described and illustrated in Part I.

Load Vehicle

The load vehicle used for trafficking test lanes in Section 13 is shown in figure 2. Load cart construction, details of linkage between the load compartment and prime mover, and method of applying load are explained in Part I. For trafficking lanes 28 and 29, a twin-wheel assembly was used with a 70,000-lb test load. The assembly consisted of two 25.00x28, 30-ply aircraft tires inflated to 50 psi with wheel spacing 58.5 and 29.5 in. c-c for lanes 28 and 29, respectively. Tire-print data and pertinent tire characteristics are given in figure 17.

SECTION III: APPLICATION OF TRAFFIC, FAILURE CRITERIA, AND DATA COLLECTED

Application of Traffic

Traffic was applied to the test lanes in a nonuniform pattern with intensity of traffic being varied within each lane to produce three zones of approximately 100, 80, and 20 percent traffic coverage. Traffic so distributed within a traffic lane simulates as nearly as possible the bell-shaped traffic distribution curve which results from the wander of aircraft from the lane center line. The coverage levels referred to in the tables and text herein are the total number of coverages applied to the 100 percent coverage zone. The corresponding number of coverages applied to the outer traffic zones is proportional to the percentage factor for the respective zones as shown in figure 1. Typically, the lane widths used were not exact multiples of the tracking tire widths and spacings so that it was necessary to determine a coverage factor for each lane to compensate for overlap or gaps in the traffic pattern.

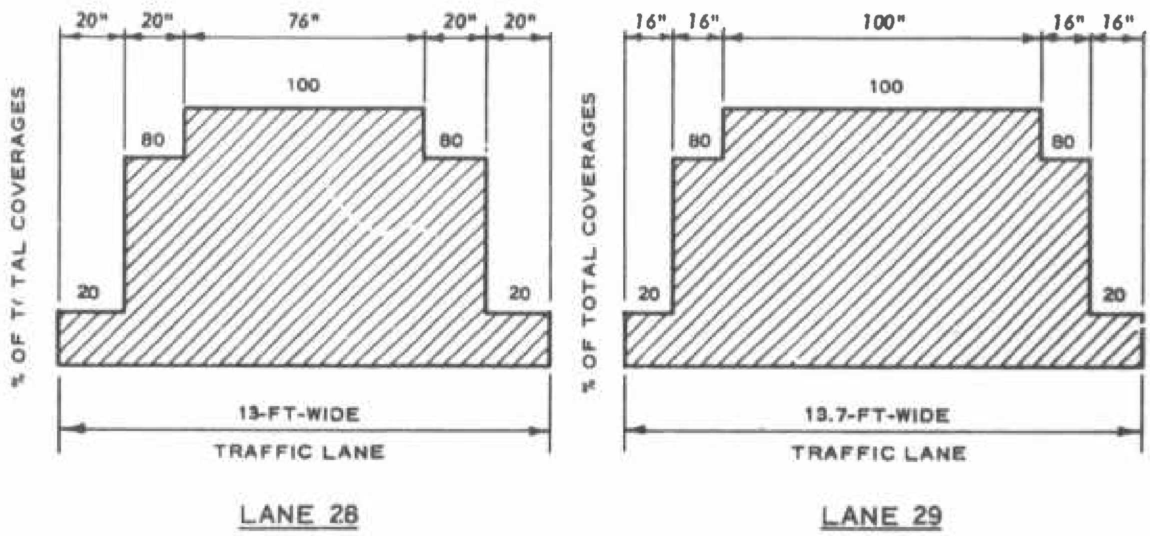


Figure 1. Traffic distribution patterns on Test Section 13

Failure Criteria and Data Collected

Failure criteria used in this investigation and descriptive terms used in presentation and discussion of data in all parts in this report are presented in Part I. A general outline of types of data collected is given in the following paragraphs. Details on apparatus and procedure for obtaining specific measurements are given in Part I.

CBR, water content, and dry density

CBR, water content, and dry density of the subgrade were measured for each test item prior to application of traffic, at intermediate coverage levels, and at failure. After traffic was concluded on an item, a measure of subgrade strength termed "rated CBR" was determined. Rated CBR is generally the average CBR value obtained from all the determinations made in the top 12 in. of soil during the test life of an item. In certain instances, extreme or irregular values may be ignored if the analyst decides that they are not properly representative.

Surface roughness, or differential deformation

Surface roughness, or differential deformation, measurements were made using a 10-ft straightedge at various traffic-coverage levels on all items. Rut depths were measured for unsurfaced items, and dishing effects of individual mat panels in the mat-surfaced items were recorded.

Deformations

Deformations, defined as permanent cumulative surface changes in cross section or profile of an item, were charted by means of level readings at pertinent traffic-coverage levels.

Deflection

Deflection of the test surface under an individual static load of the tracking assembly was measured at various traffic-coverage levels on both surfaced and unsurfaced items. Level readings on the item surface on each side of the load wheels and on a pin and cap device directly beneath a load wheel provided deflection data. Both total (for a single loading) and elastic (recoverable) deflections were measured on unsurfaced items. All mat deflection was for practical purposes recoverable, i.e. total deflection equaled elastic deflection. The pin and cap device for measuring deflection directly beneath load wheels was applied to the subgrade of surfaced items through a hole (existing or cut) in the mat.

Rolling resistance

Rolling resistance, or drawbar pull, measurements were performed with the load vehicle over each test item at designated coverage levels. Three types of drawbar measurements were taken: (a) maximum force required to overcome static inertia and commence forward movement of the load cart, termed "initial DBP"; (b) average force required to maintain a constant speed once the load vehicle is in motion, termed "rolling DBP"; and (c) maximum force obtained during the constant speed run, termed "peak DBP."

Mat breaks

Mat breaks on the surfaced items were inspected, classified by type, and recorded at various coverage levels.

SECTION IV: BEHAVIOR OF ITEMS UNDER TRAFFIC AND TEST RESULTS

Lane 28

Behavior of items under traffic

Item 1. Figure 3 shows item 1 prior to traffic. At 550 coverages traffic was temporarily halted because the tires were rubbing the saddle of the load cart. At this point all pertinent data were gathered including CBR determinations. The tires were respaced to 56 in. c-c and traffic continued. Item 1 was considered failed at 700 coverages due to elastic deflection (figure 4). The rated CBR was 2.1.

Item 2. Figure 5 shows item 2 prior to traffic. The item held up well under traffic with relatively few mat breaks and deformation which developed slowly. Item 2 was considered failed at 700 coverages due to roughness (figure 6). The rated CBR was 2.8.

Item 3. Figure 7 shows item 3 prior to traffic. Considerable subgrade settlement occurred as trafficking progressed but differential deformations and rutting were slow in developing. The item was considered failed at 200 coverages (figure 8). At failure average transverse and diagonal differential deformations considerably exceeded rutting. The rated CBR of the item was 4.7.

Test results

Results of trafficking lane 28 are summarized in table 1. Soil test data are given in table 2. Table 1 contains drawbar pull values for the load vehicle operated over an asphalt-paved strip for comparison with drawbar pull values recorded on the test lane.

Item 1. Item 1 was considered failed at 700 coverages due to elastic deflection. The following information was obtained from traffic tests on item 1.

a. Roughness. At failure the average transverse and diagonal differential deformations were 1.35 and 1.54 in., respectively (table 1). Average dishing of individual panels was 0.38 in. at failure.

b. Deformation. Average cross-section and profile deformations are shown in figures 18 and 19, respectively, for several coverage levels. The figures show very little mat deformation although there was considerable subgrade settlement. The maximum profile deformation at failure was 1.7 in. along the joint line 1.5 ft west of the lane center line.

c. Deflections. Average elastic mat deflections shown in figure 20 increased generally with traffic. The largest average deflection (4.10 in.) was recorded with the load wheels centered on a panel end joint at the 700-coverage level. At the same coverage level, the elastic subgrade deflection was 1.1 in. Elastic mat deflections were greatly exaggerated by the mat standoff, or bridging effect resulting from settlement of the subgrade with traffic.

d. Rolling resistance. Table 1 shows drawbar pull values at several coverages. Initial, peak, and rolling drawbar pull values showed consistant increases with continued traffic.

e. Mat breaks. The number and types of mat breaks are given in table 1. Relatively few mat breaks occurred with most of these being rivet failures.

Item 2. The item was considered failed due to roughness at 700 coverages. The following information was obtained from traffic tests on item 1.

a. Roughness. At failure the average transverse and diagonal differential deformations were 2.88 and 2.50 in., respectively (table 1). The average dishing of individual panels was 0.23 in. at failure.

b. Deformation. Average cross-section deformations are shown in figure 18. The maximum average cross-section deformation at failure was 2.35 in. approximately 2 ft either side of the traffic lane center line. Profiles in figure 19 indicate the severe longitudinal deformations that existed in the item at failure, especially at the end adjacent to item 1.

c. Deflection. Average elastic mat deflections are shown in figure 20. Table 1 shows elastic subgrade deflections beneath a load wheel for several coverage levels. Elastic subgrade deflection at failure was 0.70 in.

d. Rolling resistance. Initial, peak, and rolling drawbar pull values increased with traffic coverage. Table 1 gives drawbar values for various coverages through the 700-coverage level.

e. Mat breaks. The number and types of mat breaks are given in table 1. There were relatively few mat breaks at failure.

Item 3. Item 3 was considered failed at 200 coverages due to roughness. The following information was obtained from traffic tests on item 3.

a. Roughness. At failure, the average transverse and diagonal differential deformations were 4.16 and 4.41 in., respectively (table 1). The average rut depth at failure was 3.28 in.

b. Deformation. Average cross-section deformations at 40 and 200

coverages are shown in figure 18. Considerable rutting developed between the two coverage levels. Figure 19 shows profiles for 40 and 200 coverages and illustrates the progressive subsidence of the item with traffic.

c. Deflection. Total subgrade deflections are shown in figure 20 for 0, 40, and 200 coverages. Maximum deflection occurred at 40 coverages. Elastic subgrade deflections shown in table 1 decreased with traffic.

d. Rolling resistance. Consistent increases in initial, peak, and rolling drawbar pull were measured as coverage levels increased (table 1).

Lane 29

Behavior of items under traffic

Item 1. Item 1 prior to traffic is shown in figure 9. The item was considered failed at 140 coverages due to roughness (figure 10). As trafficking continued, the subgrade was laterally displaced from the lane center line resulting in subgrade subsidence and consequent mat standoff, or bridging, of approximately 2.5 in. with noticeable effect on measured deformation and deflection. The rated CBR was 1.8.

Item 2. Item 2 prior to traffic is shown in figure 11. The item was considered failed at 200 coverages due to roughness (figure 12). The rated CBR was 2.8.

Item 3. Item 3 prior to traffic is shown in figure 13. The item was considered failed at 200 coverages due to roughness (figure 14). The rated CBR was 4.5.

Test results

Results of trafficking lane 29 are summarized in table 1. Soil test data are given in table 2. Table 1 contains drawbar pull values for the load vehicle operated over an asphalt-paved strip for comparison with drawbar values recorded on the test lane.

Item 1. Item 1 was considered failed at 140 coverages. The following information was obtained from traffic tests on item 1.

a. Roughness. At failure, the average transverse and [illegible]nal differential deformations were 1.62 and 1.75 in., respectively (table 1). Dishing averaged 0.40 in.

b. Deformation. Average cross-section and profile deformations are

shown in figures 18 and 19, respectively. The maximum average cross-section deformation was +1.9 in. and occurred along the west side of the lane. This positive deformation was due to lateral displacement of the subgrade under traffic. Figure 19 shows deformations at 42 and 140 coverages. Displacement and subsidence of the subgrade under traffic caused bridging of the mat surface and consequently a number of positive deformation readings were recorded at 140 coverages.

c. Deflections. Deflections shown in figure 20 increased consistently with traffic. The large deflection measurements were due to the mat standoff effect resulting from subsidence of the subgrade. Elastic subgrade deflection at failure was 2.2 in. (table 1).

d. Rolling resistance. Initial, peak, and rolling drawbar pull values at several coverage levels are shown in table 1. Rolling and peak drawbar pull increased consistently with traffic, while initial drawbar pull decreased slightly at 140 coverages.

e. Mat breaks. Number of breaks by type are shown in table 1. There were a large number of rivet failures at 140 coverages.

Item 2. Item 2 was considered failed due to roughness at 200 coverages. The following information was obtained from traffic tests on item 2.

a. Roughness. At failure, the average transverse and diagonal differential deformations were 3.53 and 3.60 in., respectively (table 1). Dishing of individual panels was insignificant.

b. Deformations. Average cross-section deformations at 42, 140, and 200 coverages are shown in figure 18 for the two typical mat runs. The magnitude of deformations at 140 and 200 coverages is approximately the same, with both showing large increases over the 42-coverage values. Profiles along the item are shown in figure 19 for 42, 140, and 200 coverages. Very consistent increases in profile deformations occurred with traffic. The most severe deformation occurred at the south end of the item adjacent to the previously failed item 1.

c. Deflection. Average elastic mat deflections for three positions of the wheel assembly relative to mat joints are plotted in figure 20. Deflections did not vary greatly at the different coverage levels shown. Elastic subgrade deflection at failure was 1.50 in. (table 1).

d. Rolling resistance. Drawbar pull values increased with traffic (table 1). Rolling drawbar pull showed the greatest relative increase, going from 2.9 kips prior to traffic to 4.8 kips at failure.

e. Mat breaks. No mat breaks were evident at failure of the item.

Item 3. Item 3 was considered failed at 200 coverages. The following information was obtained from traffic tests on item 3.

a. Roughness. Average transverse and diagonal differential deformations were 5.10 and 5.13 in., respectively, at failure (table 1). No rut depth measurements were made at failure because the close spacing of the tracking tires made individual ruts indistinguishable.

b. Deformation. Average cross-section deformations for 42, 140, and 200 coverages are shown in figure 18. Deformations became increasingly severe with traffic, reaching 4.0 in. at failure. Figure 19 shows profile deformations for the same coverage levels, illustrating the very large increase that occurred between 140 and 200 coverages, especially on the end adjacent to mat-surfaced item 2.

c. Deflection. Total subgrade deflections shown in figure 20 somewhat erratic at intermediate coverage levels but yielded greatest values at failure. Table 1 shows elastic subgrade deflections with a value of 0.65 in. at failure.

d. Rolling resistance. Drawbar pull values increased steadily with traffic (table 1). Rolling drawbar pull registered the greatest relative increase.

SECTION V: PRINCIPAL FINDINGS

From the foregoing discussion, the principal findings relating test load, wheel assembly, tire inflation pressure, surface type, subgrade CBR, and traffic coverages are as follows:

Load, Wheel Assembly, and Tire Pressure	Type of Surface	Rated Subgrade CBR	Coverages at Failure
70,000-lb load; twin-wheel assembly (58.5 in. c-c*); 25.00x28, 30-ply tires inflated to 50 psi	Modified T11 aluminum mat	2.1	700
	M8 steel mat	2.8	700
	Unsurfaced	4.7	200
70,000-lb load; twin-wheel assembly (29.5 in. c-c); 25.00x28, 30-ply tires inflated to 50 psi	Modified T11 aluminum mat	1.8	140
	M8 steel mat	2.8	200
	Unsurfaced	4.5	200

* Because of tracking equipment difficulties, it was necessary to respace wheels at 56 in. c-c at 550 coverages before continuing traffic.

TABLE 1

SUMMARY OF TRAFFIC DATA, TEST SECTION 13

Test Item	Coverages	Rated CBR	No. of Mat Breaks* A	B	C	D	E	Differential Deformation (in.) Longitudinal Max	Longitudinal Avg	Transverse Max	Transverse Avg	Diagonal Max	Diagonal Avg	Dishing or Rutting (in.) Max	Dishing or Rutting (in.) Avg	[illegible] wheel [illegible] (kips) Initial	Peak	Rolling	Average Total Deflection (in.) with Center Line of Assembly Located on: Unsurfaced Item Max	Unsurfaced Item Center Line of Assembly	Quarter Point of Panel Max	Quarter Point of Panel Center Line of Assembly	Half Point of Panel Max	Half Point of Panel Center Line of Assembly	Joint of Panel Max	Joint of Panel Center Line of Assembly	Elastic Subgrade Deflection (in.)	Remarks
Lane 28																												
1 Modified T11 aluminum landing mat	0		--	--	--	--	--	--	--	--	--	--	--	--	--	6.50	3.70	2.60	--	--	1.60	1.30	1.60	1.10	1.60	1.10	--	Failed at 700 coverages due to elastic deflection
	20		--	--	--	--	--	0.50	0.35	0.63	0.41	0.63	0.50	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
	40		--	--	--	--	--	0.63	0.44	0.75	0.63	0.75	0.60	0.25	0.25	6.70	4.10	2.90	--	--	1.60	1.55	1.65	1.50	1.65	1.30	--	
	100		--	--	--	--	--	0.63	0.50	1.00	0.63	1.00	0.66	0.38	0.38	--	--	--	--	--	--	--	--	--	--	--	--	
	200	2.1	--	--	--	--	--	0.75	0.66	0.75	0.69	1.13	0.72	0.38	0.32	7.30	5.10	3.70	--	--	2.40	1.90	2.60	2.10	2.80	2.20	--	
	260		--	3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
	360		--	4	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
	550		7	8	1	--	--	1.25	1.03	1.25	1.16	1.25	1.19	0.25	0.25	7.40	5.30	3.70	--	--	3.30	2.20	3.30	2.85	3.60	3.15	1.30	
	600		7	11	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
	700		7	13	1	4	--	1.57	1.09	1.63	1.35	1.88	1.54	0.50	0.38	8.10	6.40	4.30	--	--	3.60	2.70	3.60	3.30	4.10	3.80	1.10	
2 M8 steel landing mat	0		--	--	--	--	--	--	--	--	--	--	--	--	--	6.60	4.50	2.50	--	--	1.10	0.50	1.00	0.50	1.00	0.50	0.85	Failed at 700 coverages due to roughness
	20		--	--	--	--	--	0.38	0.32	0.50	0.37	0.63	0.47	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
	40		--	--	--	--	--	0.38	0.32	0.63	0.50	0.88	0.72	--	--	6.50	4.60	2.90	--	--	1.00	0.50	1.00	0.60	0.90	0.15	0.33	
	100		--	--	--	--	--	0.50	0.38	1.13	0.78	1.00	0.63	0.25	0.18	--	--	--	--	--	--	--	--	--	--	--	--	
	200	2.8	3	--	--	--	--	0.25	0.22	1.50	1.22	1.13	1.10	0.25	0.16	6.80	5.30	3.20	--	-	1.30	0.45	0.90	0.70	1.10	0.25	0.65	
	260		8	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
	360		12	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
	550		13	1	--	--	--	1.00	0.78	2.00	1.75	2.13	1.72	0.25	0.22	7.60	7.00	3.40	--	--	1.50	0.45	1.30	0.80	1.30	0.45	0.63	
	600		13	3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
	700		13	7	9	4	--	1.00	0.94	3.00	2.88	4.75	2.50	0.38	0.23	8.50	7.00	3.90	--	--	1.50	0.60	1.00	1.00	1.70	0.65	0.70	
3 Unsurfaced	0		--	--	--	--	--	--	--	--	--	--	--	--	--	7.80	4.60	3.20	1.10	0.00	--	--	--	--	--	-	0.70	Failed at 200 coverages due to roughness
	20		--	--	--	--	--	0.38	0.32	1.50	1.38	1.63	1.50	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
	40	4.7	--	--	--	--	--	0.50	0.44	2.75	2.06	2.75	2.06	1.25	1.19	7.70	5.00	3.50	1.30	0.10	--	--	--	--	--	--	0.60	
	100		--	--	--	--	--	0.75	0.60	3.13	2.47	3.75	2.88	1.38	1.16	--	--	--	--	--	--	--	--	--	--	--	--	
	180		--	--	--	--	--	1.50	0.97	4.75	4.10	5.25	4.47	4.13	3.10	--	--	--	--	--	--	--	--	--	--	--	--	
	200		--	--	--	--	--	1.88	1.63	4.75	4.16	5.25	4.41	4.13	3.28	9.50	6.00	4.20	0.70	0.10	--	--	--	--	--	--	0.20	
Asphalt strip			--	--	--	--	--	--	--	--	--	--	--	--	--	6.40	5.00	2.30	--	--	--	--	--	--	--	--	--	
Lane 29																												
1 Modified T11 aluminum landing mat	0		--	--	--	--	--	--	--	--	--	--	--	--	--	7.50	4.10	3.00	--	--	1.60	1.50	1.30	1.20	1.60	1.60	--	Failed at 140 coverages due to roughness
	42		--	--	--	--	--	1.38	0.34	0.88	0.73	1.44	1.10	0.50	0.38	8.80	6.50	4.60	--	--	3.20	3.00	2.90	2.80	2.80	2.80	--	
	70		--	2	--	4	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
	84	1.8	--	5	--	16	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
	98		--	13	--	20	--	1.88	1.44	1.50	1.16	1.75	1.41	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
	140		--	22	--	39	--	1.50	1.22	2.13	1.68	2.25	1.75	0.58	0.40	8.50	6.60	4.80	--	--	3.50	3.40	4.20	3.90	3.80	3.70	2.20	
2 M8 steel landing mat	0		--	--	--	--	--	--	--	--	--	--	--	--	--	7.20	4.80	2.90	--	--	1.20	1.10	1.20	1.10	1.10	1.10	0.87	Failed at 270 coverages due to roughness
	42		--	--	--	--	--	1.00	0.44	1.68	1.25	1.38	1.10	--	--	7.90	4.90	3.70	--	--	1.40	1.40	1.40	1.40	1.30	1.30	1.20	
	70		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
	84		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
	98	2.8	--	--	--	--	--	0.75	0.56	1.63	1.28	1.63	1.35	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
	140		--	--	--	--	--	0.63	0.50	2.88	2.34	2.50	2.28	--	--	7.90	6.80	4.30	--	--	1.40	1.20	1.50	1.50	1.40	1.40	1.30	
	172		--	--	--	--	--	0.88	0.56	3.75	3.41	3.50	3.35	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
	200		--	--	--	--	--	1.75	0.97	4.00	3.53	3.88	3.60	--	--	8.10	8.00	4.80	--	--	1.50	1.30	1.40	1.40	1.30	1.30	1.50	
3 Unsurfaced	0		--	--	--	--	--	--	--	--	--	--	--	--	--	7.60	3.90	2.80	0.60	0.60	--	--	--	--	--	--	0.30	Failed at 200 coverages due to roughness
	42		--	--	--	--	--	0.50	0.25	1.88	1.63	1.88	1.75	1.50	1.10	8.80	5.30	4.00	0.90	0.80	--	--	--	--	--	--	0.60	
	70		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
	84	4.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
	98		--	--	--	--	--	0.50	0.31	2.63	1.75	2.63	1.53	1.50	1.10	--	--	--	--	--	--	--	--	--	--	--	--	
	140		--	--	--	--	--	0.63	0.53	2.63	2.22	2.63	2.28	1.50	1.10	9.10	5.80	4.30	0.60	0.60	--	--	--	--	--	--	0.45	
	172		--	--	--	--	--	0.88	0.72	4.88	4.44	4.63	4.28	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
	200		--	--	--	--	--	2.00	1.63	5.75	5.10	5.50	5.13	--	--	9.50	6.50	4.60	1.20	1.10	--	--	--	--	--	--	0.65	

Note: For trafficking both lanes, a 70-kip load was used on a twin-wheel assembly with 25.00x28, 30-ply tires inflated to 50 psi. The wheel spacings were 58.5 in. c-c and 29.5 in. c-c for lanes 28 and 29, respectively.

* Mat breaks are described and illustrated in Part I.

TABLE 2

SUMMARY OF CBR, DENSITY, AND WATER CONTENT DATA, TEST SECTION 13

Test Item*	Type of Surface	No. of Traffic Coverages	Depth (in.)	CBR	Water Content, %	Dry Density (lb/cu ft)
			Lane 28			
1	Modified T11 aluminum landing mat	0	0	1.4	33.2	86.2
			6	1.5	34.7	83.0
			12	1.6	32.6	86.7
			18	1.6	33.9	85.5
		550	0	3.0	30.0	89.9
			6	1.7	34.6	85.0
			12	2.1	33.6	85.8
			18	1.6	34.5	85.6
		700	0	2.7	33.2	86.4
			6	2.5	33.2	86.1
			12	2.8	33.1	85.9
			18	3.4	32.1	88.7
2	M8 steel landing mat	0	0	1.3	31.6	85.8
			6	2.4	29.4	88.9
			12	2.7	27.7	89.7
			18	4.4	27.1	91.9
		550	0	3.3	30.3	90.6
			6	2.5	30.5	90.6
			12	2.7	28.6	91.5
			18	3.1	30.3	89.6
		700	0	3.0	30.3	90.0
			6	3.4	30.3	90.0
			12	3.7	28.4	93.0
			18	4.6	29.9	89.7
3	Unsurfaced	0	0	4.5	28.4	91.2
			6	5.1	25.6	90.7
			12	5.1	27.7	92.6
			18	5.5	27.2	94.4
		200	0	3.9	28.[illegible]	93.7
			6	4.7	27.9	92.9
			12	5.1	27.[illegible]	93.3
			18	5.6	28.0	91.9
			Lane 29			
1	Modified T11 aluminum landing mat	0	0	1.2	33.9	83.8
			6	1.1	33.2	84.5
			12	1.[illegible]	33.2	85.7
			18	1.0	36.1	81.3
		140	0	2.2	33.4	85.2
			6	2.4	33.1	86.3
			12	2.5	34.0	84.8
			18	2.8	31.0	89.2
2	M8 steel landing mat	0	0	3.0	28.2	91.0
			6	2.3	29.1	90.5
			12	2.0	31.6	89.8
			18	2.4	31.6	87.5
		140	0	2.3	30.7	90.6
			6	3.3	30.3	89.6
			12	3.7	29.3	91.2
			18	2.8	29.[illegible]	91.1
		200	0	2.5	30.9	89.6
			6	2.3	29.0	91.3
			12	3.4	28.0	93.1
			18	2.5	30.1	90.5
3	Unsurfaced	0	0	4.5	27.4	93.0
			6	4.7	27.5	94.0
			12	4.7	28.9	90.5
			18	5.6	26.0	94.5
		140	0	5.0	27.5	92.9
			6	4.9	25.8	95.8
			12	4.1	28.5	91.8
			18	5.3	26.6	95.3
		200	0	4.0	27.6	94.4
			6	3.2	29.1	92.2
			12	4.3	28.4	92.8
			18	4.9	27.0	93.8

Note: For coverage-failure information, see remarks column in table 1.
* Subgrade material was heavy clay (classified as CH) in all items.

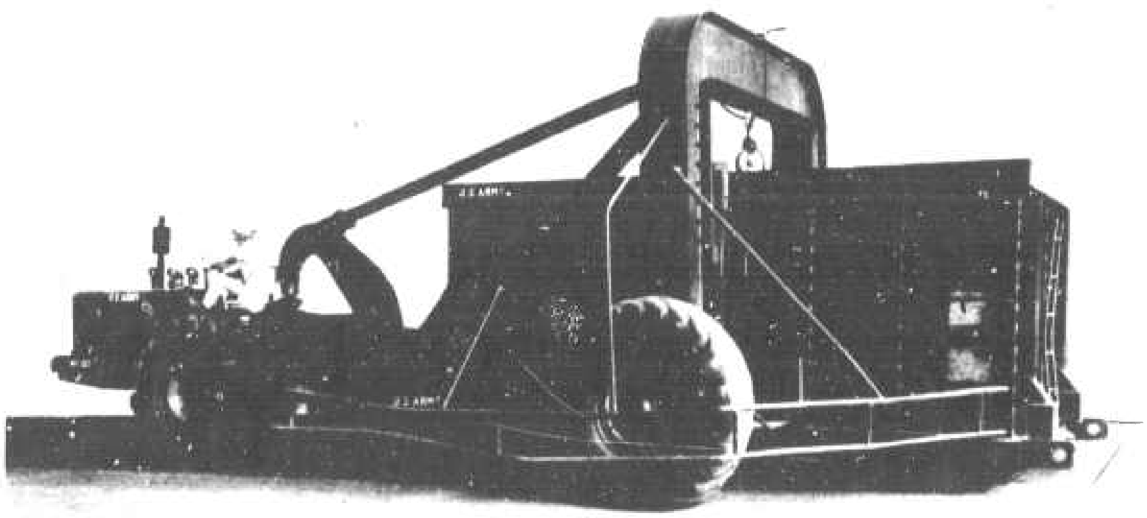


Figure 2. Load vehicle

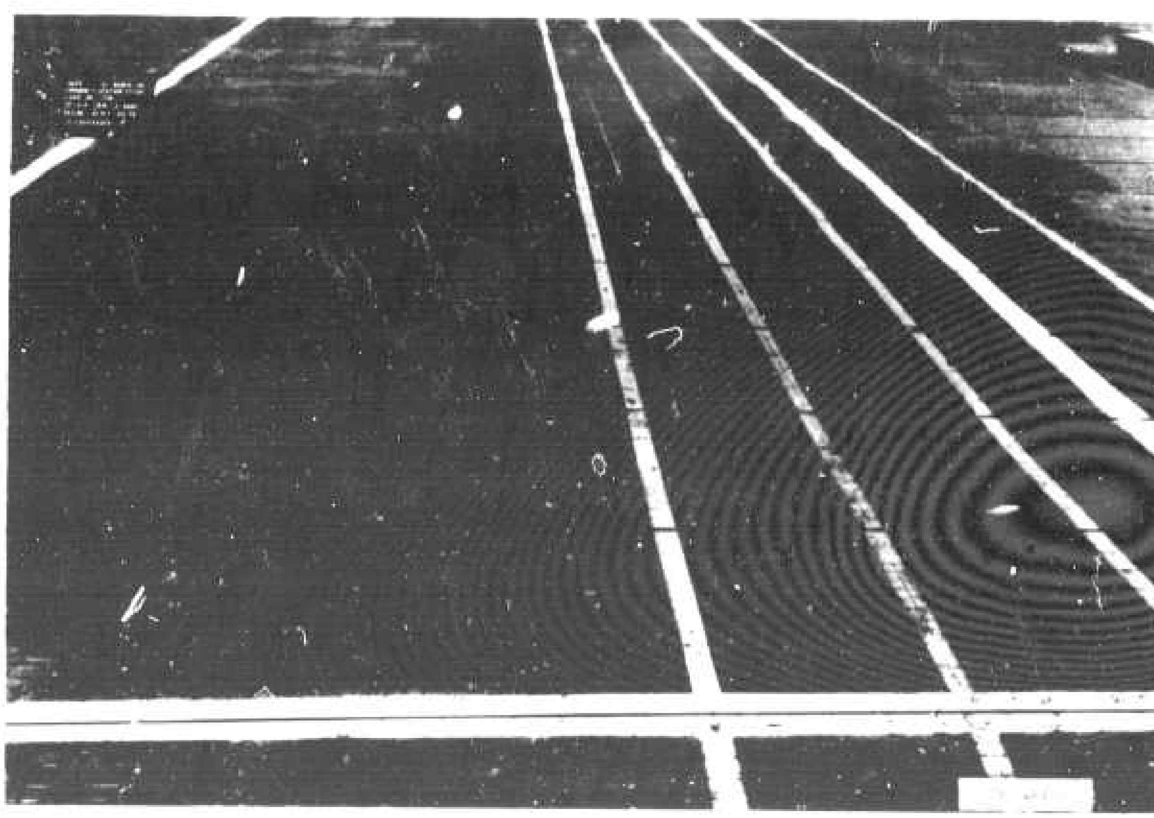


Figure 3. Lane 28, item 1, prior to traffic

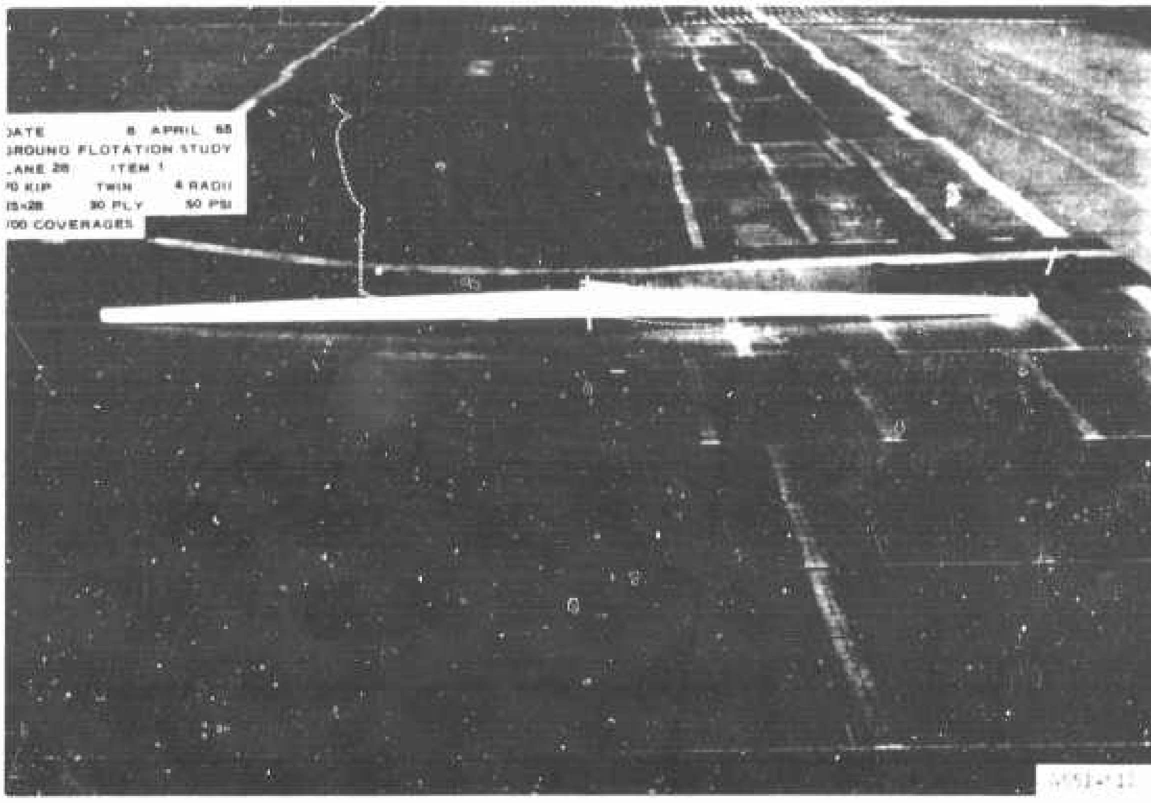


Figure 4. Lane 28, item 1, after 700 coverages of traffic (failure)

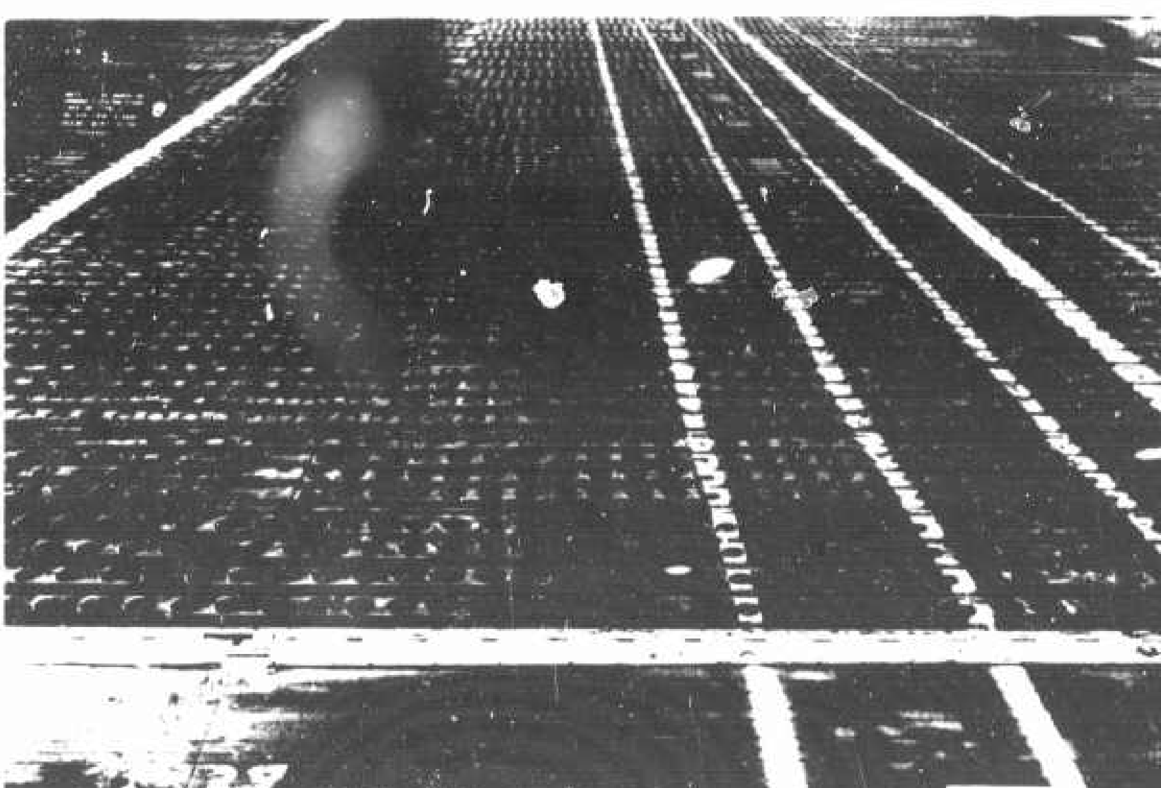


Figure 5. Lane 28, item 2, prior to traffic

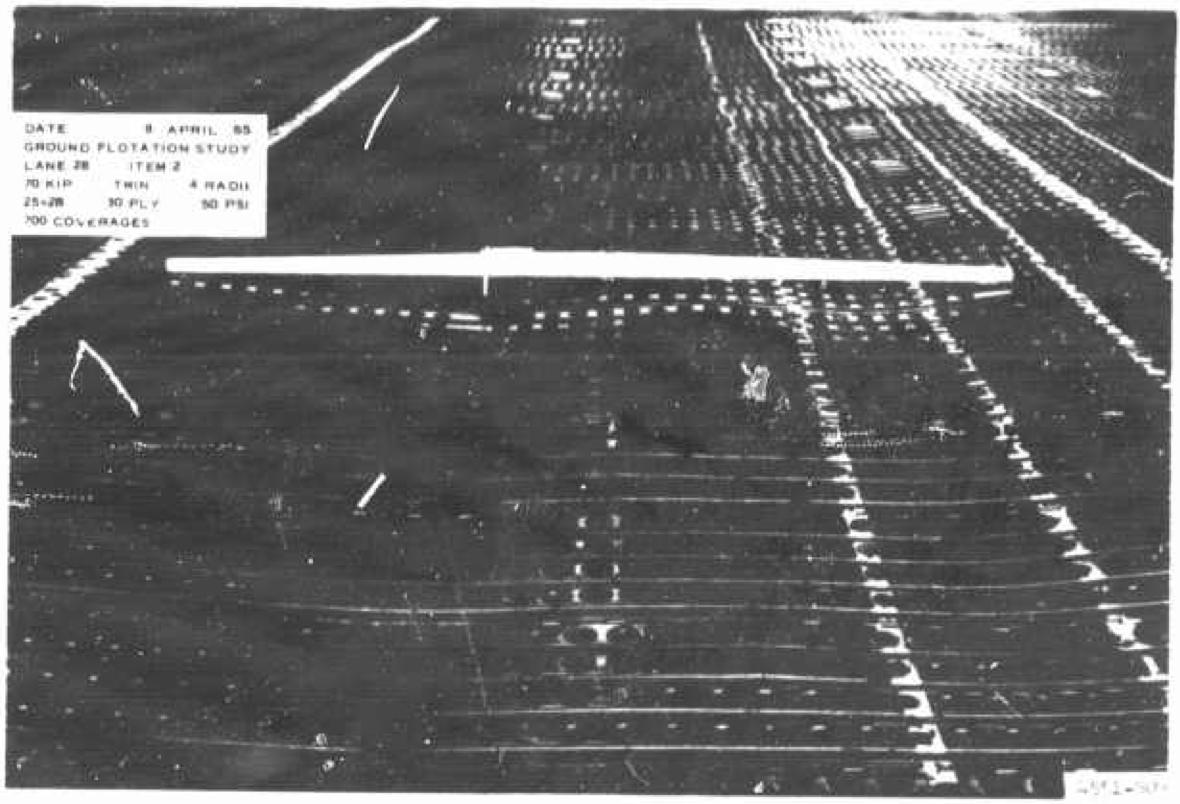


Figure 6. Lane 28, item 2, after 700 coverages of traffic (failure)

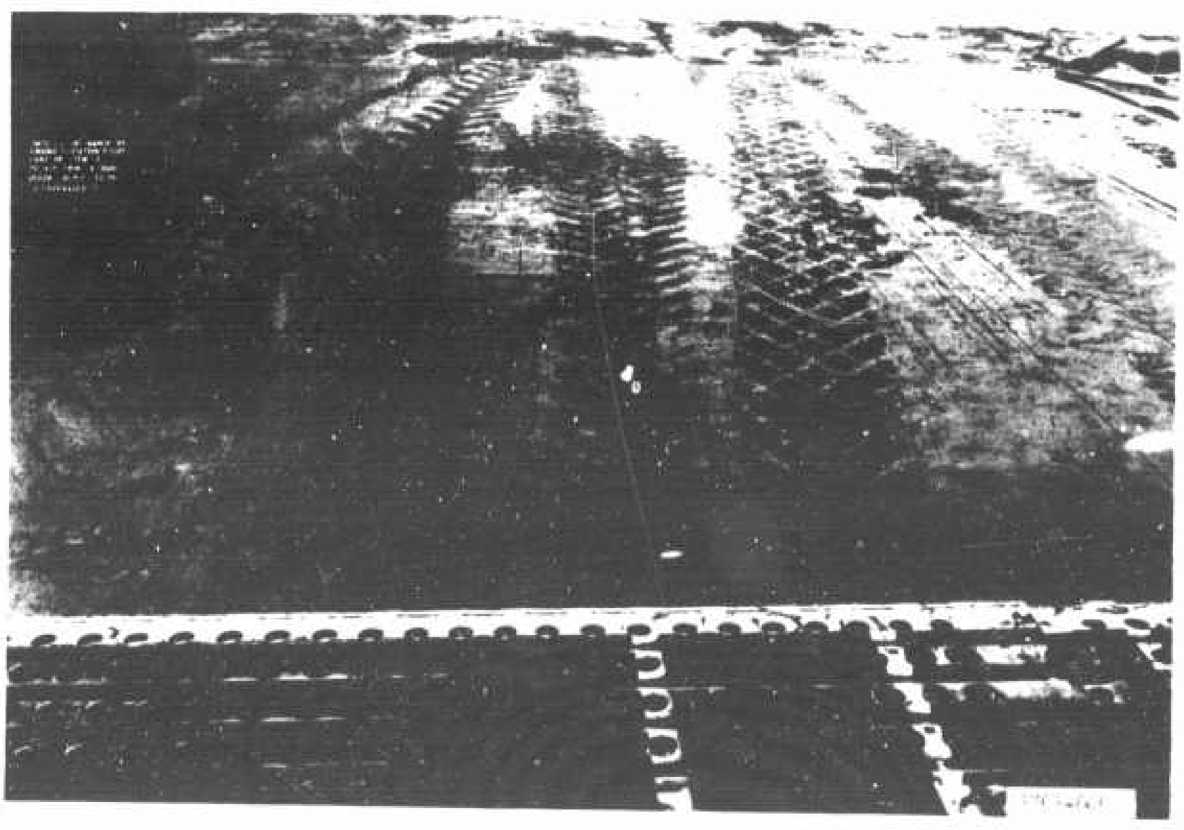


Figure 7. Lane 28, item 3, prior to traffic

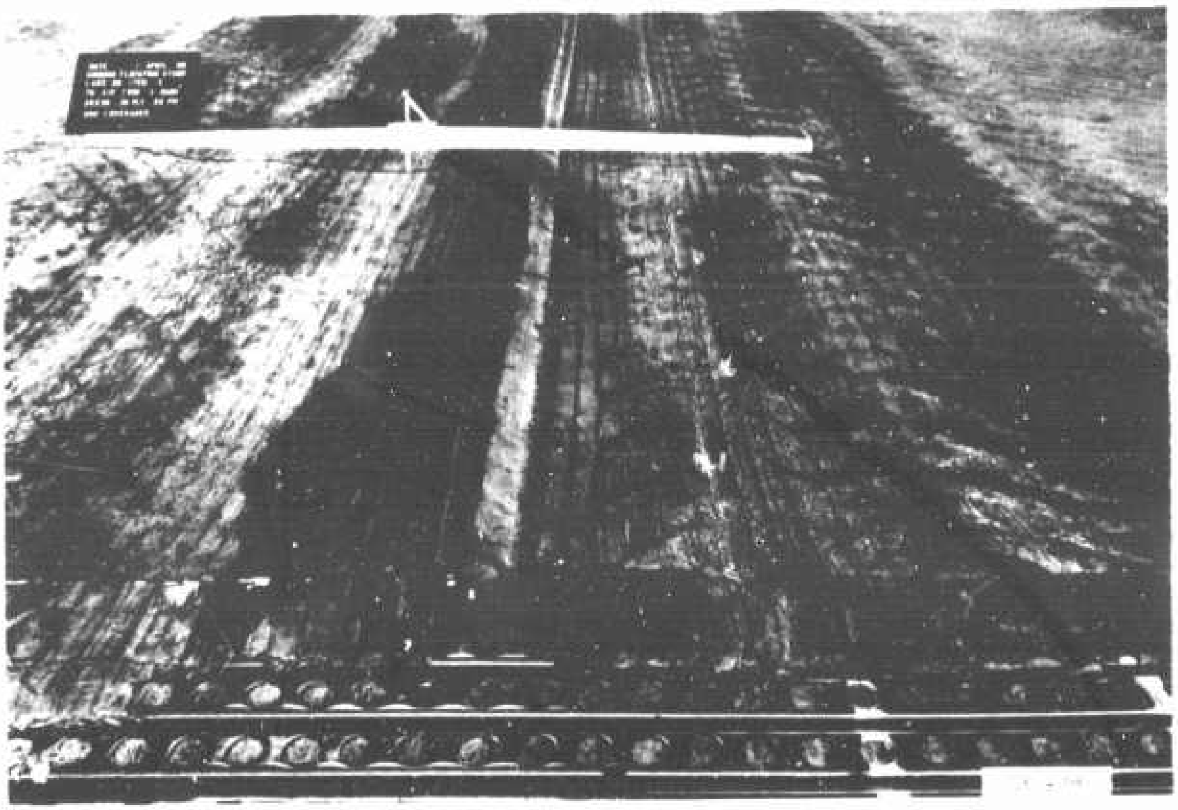


Figure 8. Lane 28, item 3, after 200 coverages of traffic (failure)

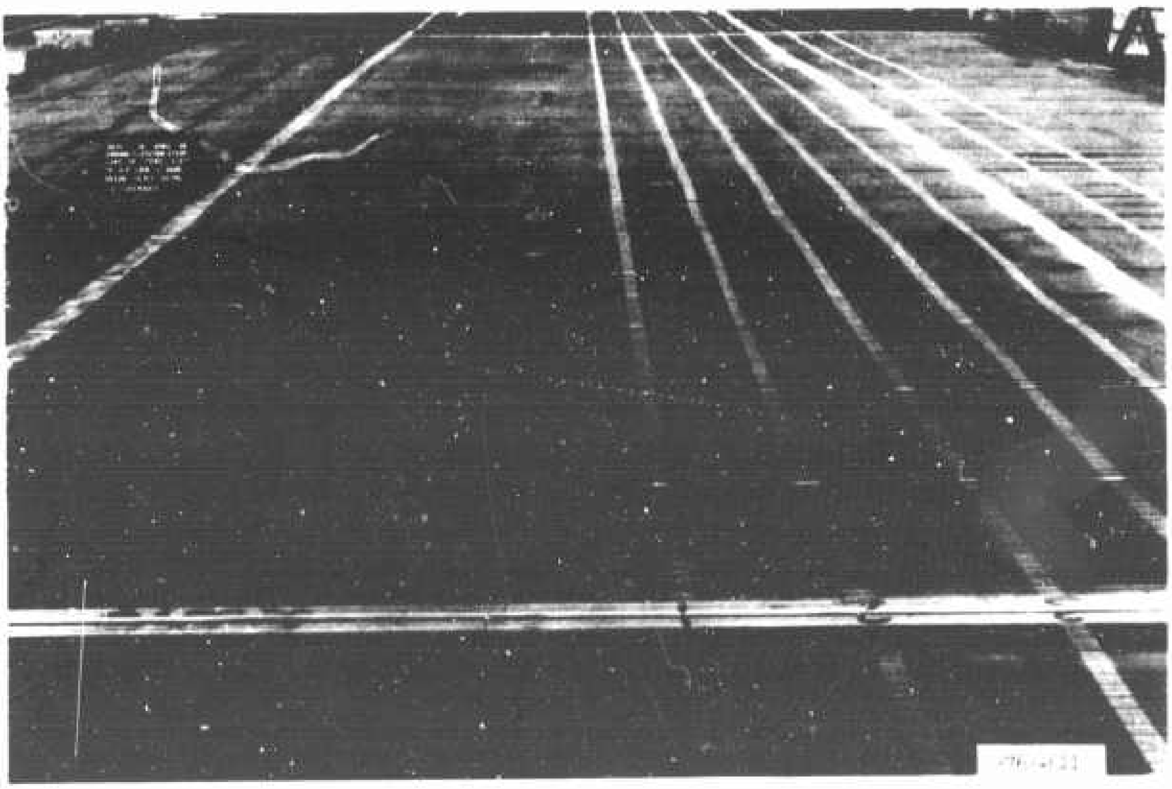


Figure 9. Lane 29, item 1, prior to traffic

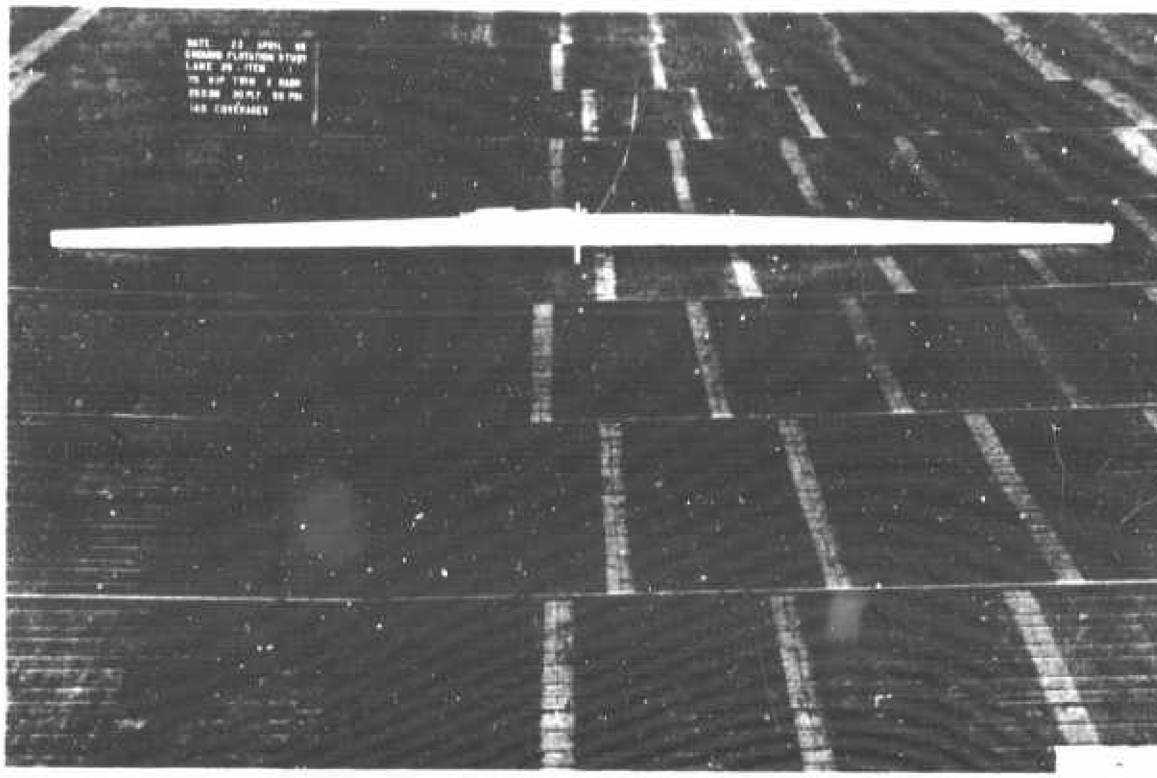


Figure 10. Lane 29, item 1, after 140 coverages
of traffic (failure)

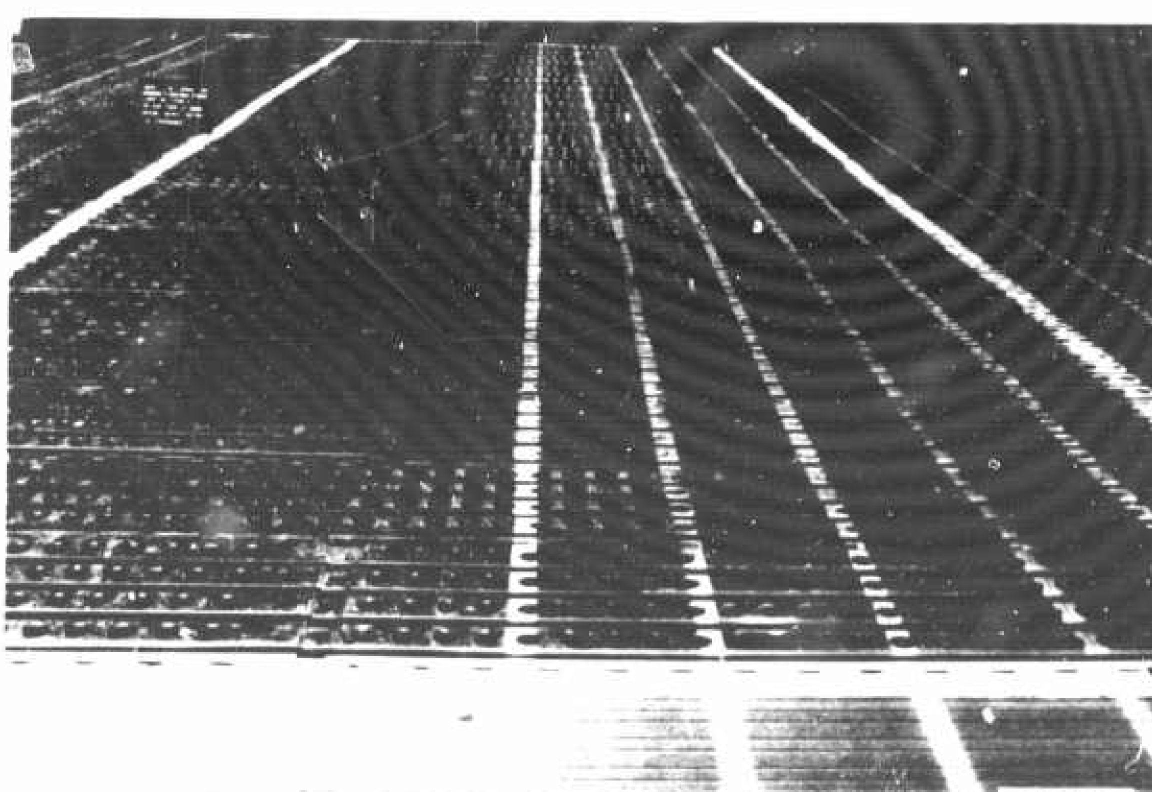


Figure 11. Lane 29, item 2, prior to traffic

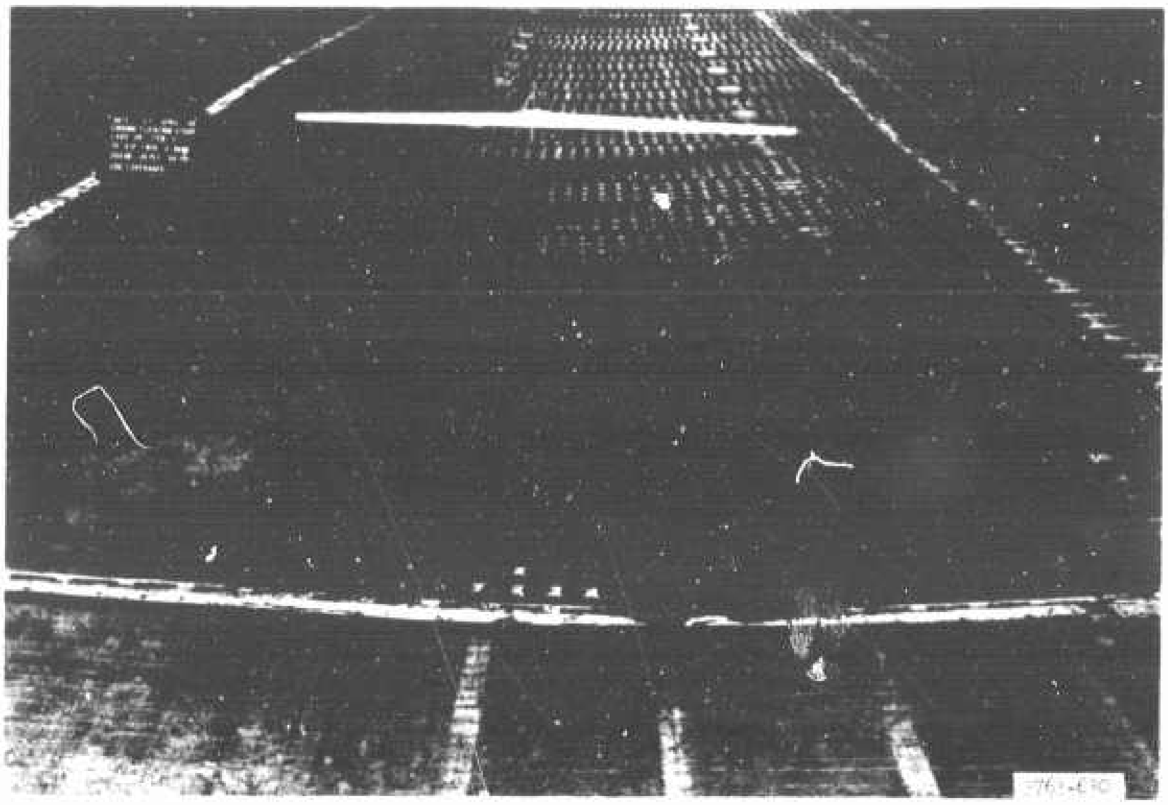


Figure 12. Lane 29, item 2, after 200 coverages of traffic (failure)

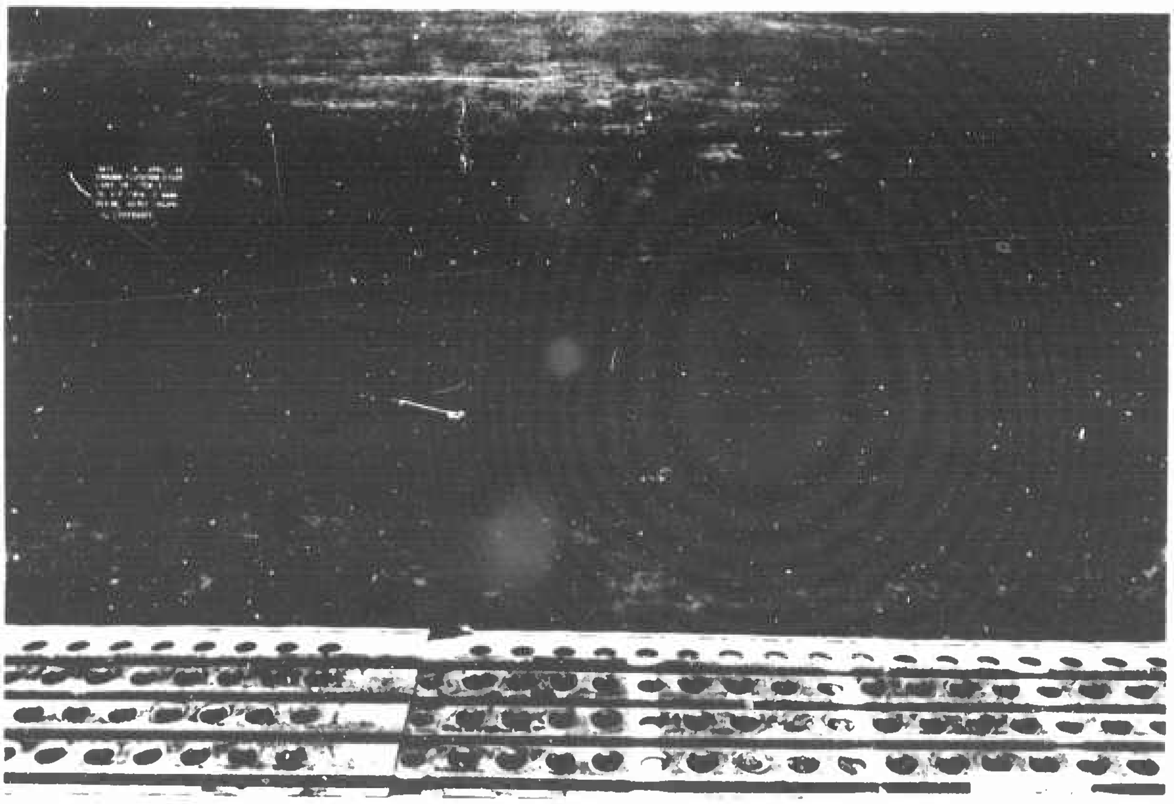


Figure 13. Lane 29, item 3, prior to traffic

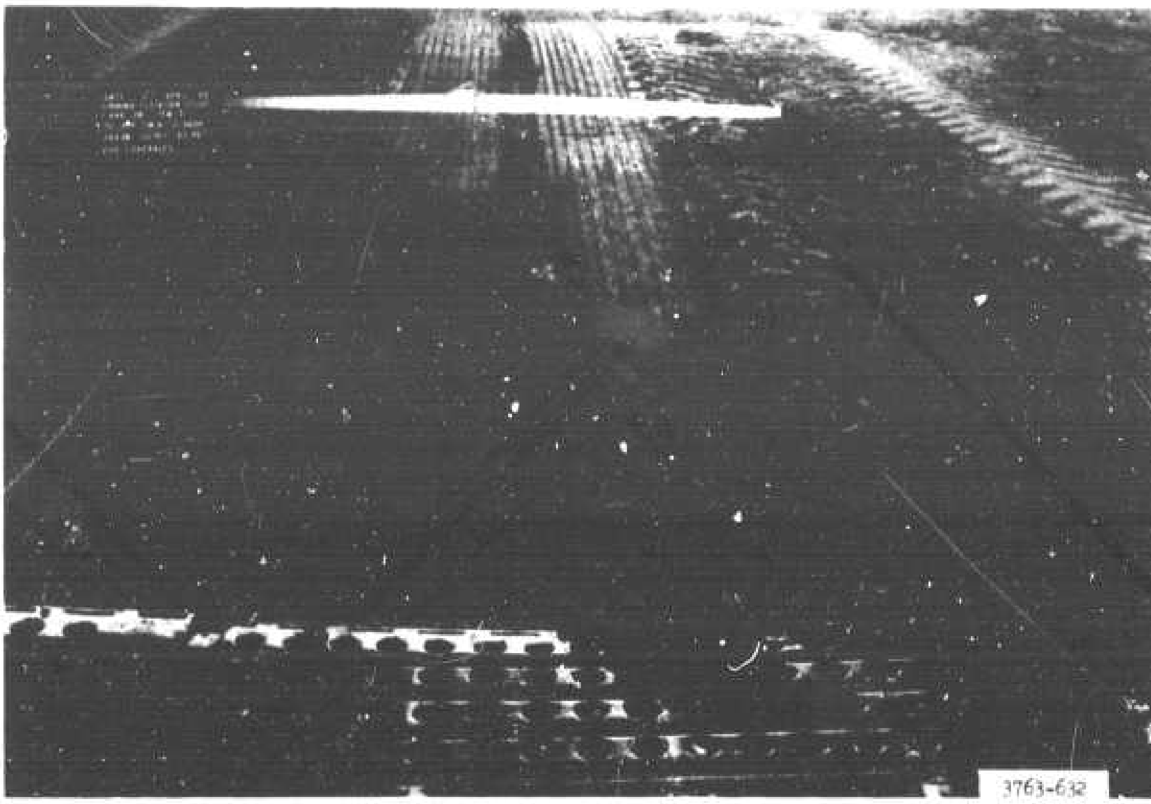


Figure 14. Lane 29, item 3, after 200 coverages of traffic (failure)

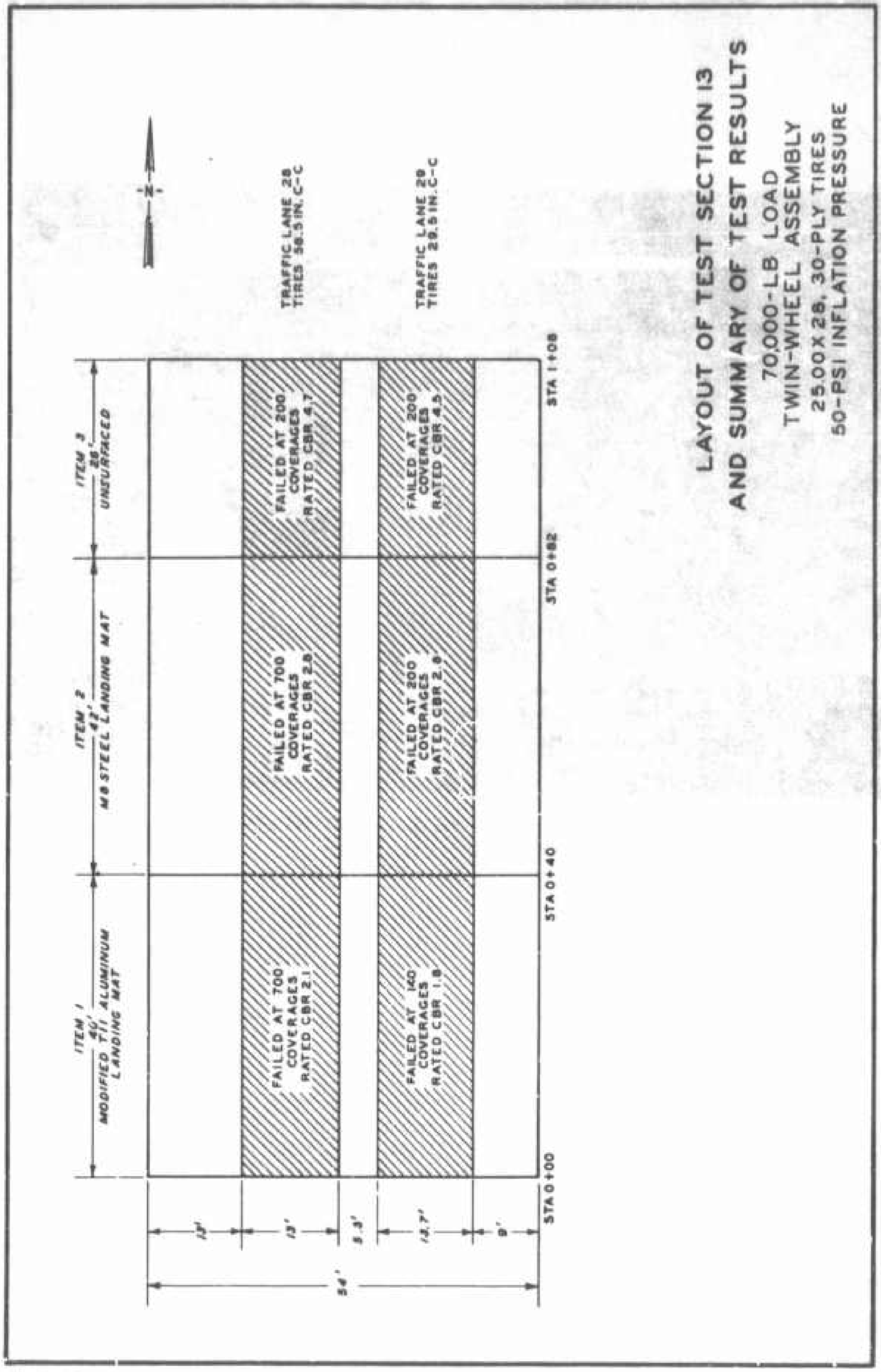

LAYOUT OF TEST SECTION 13
AND SUMMARY OF TEST RESULTS
70,000-LB LOAD
TWIN-WHEEL ASSEMBLY
25.00 X 28, 30-PLY TIRES
50-PSI INFLATION PRESSURE
N
ITEM 1
40'
MODIFIED T11 ALUMINUM LANDING MAT
ITEM 2
42'
M8 STEEL LANDING MAT
ITEM 3
26'
UNSURFACED
FAILED AT 700 COVERAGES RATED CBR 2.1
FAILED AT 140 COVERAGES RATED CBR 1.8
FAILED AT 700 COVERAGES RATED CBR 2.8
FAILED AT 200 COVERAGES RATED CBR 2.8
FAILED AT 200 COVERAGES RATED CBR 4.7
FAILED AT 200 COVERAGES RATED CBR 4.5
TRAFFIC LANE 28 TIRES 38.5 IN. C-C
TRAFFIC LANE 29 TIRES 29.5 IN. C-C
STA 0+00
STA 0+40
STA 0+82
STA 1+08
13'
13'
5.3'
12.7'
9'
54'

Figure 15

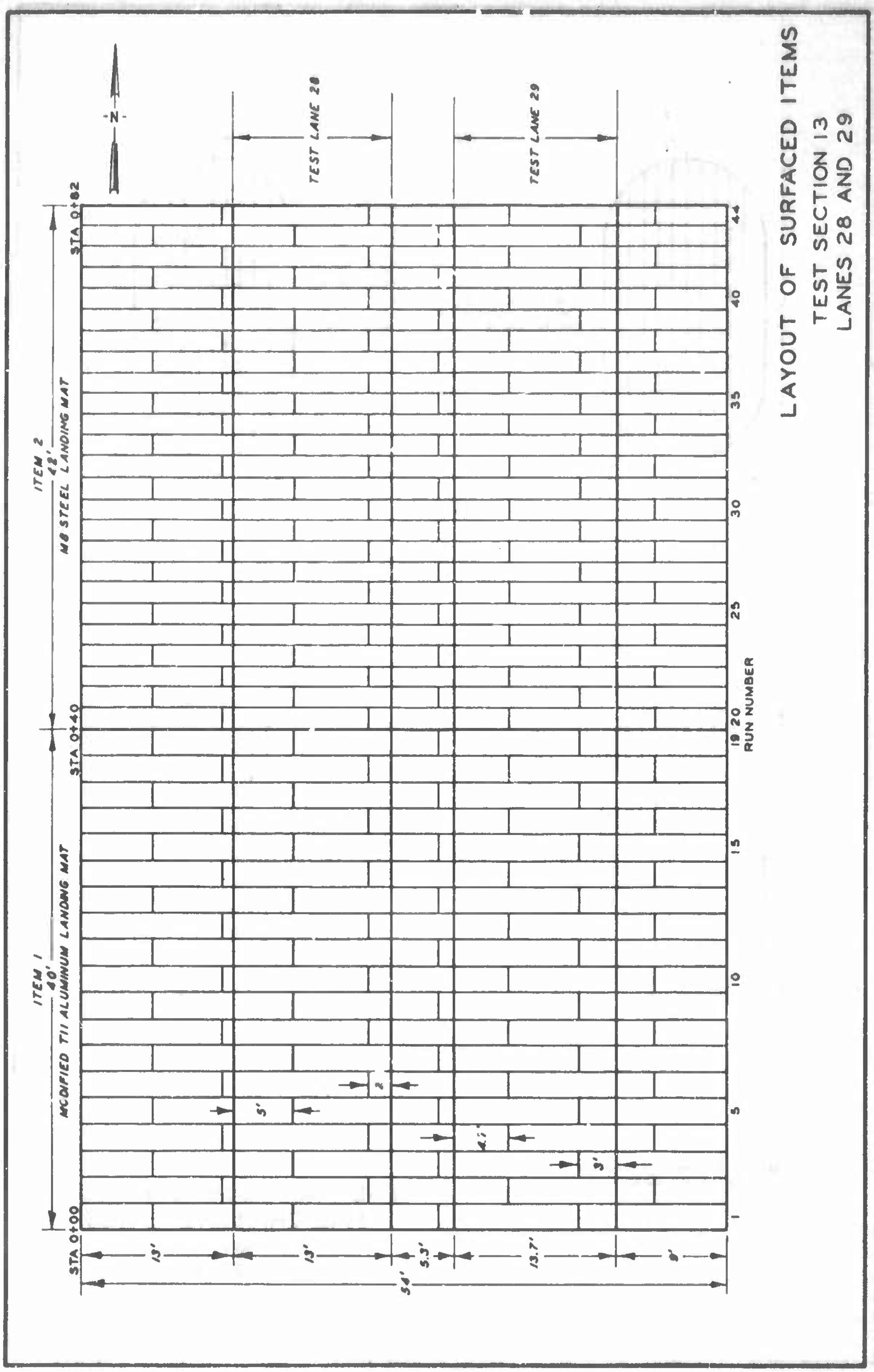
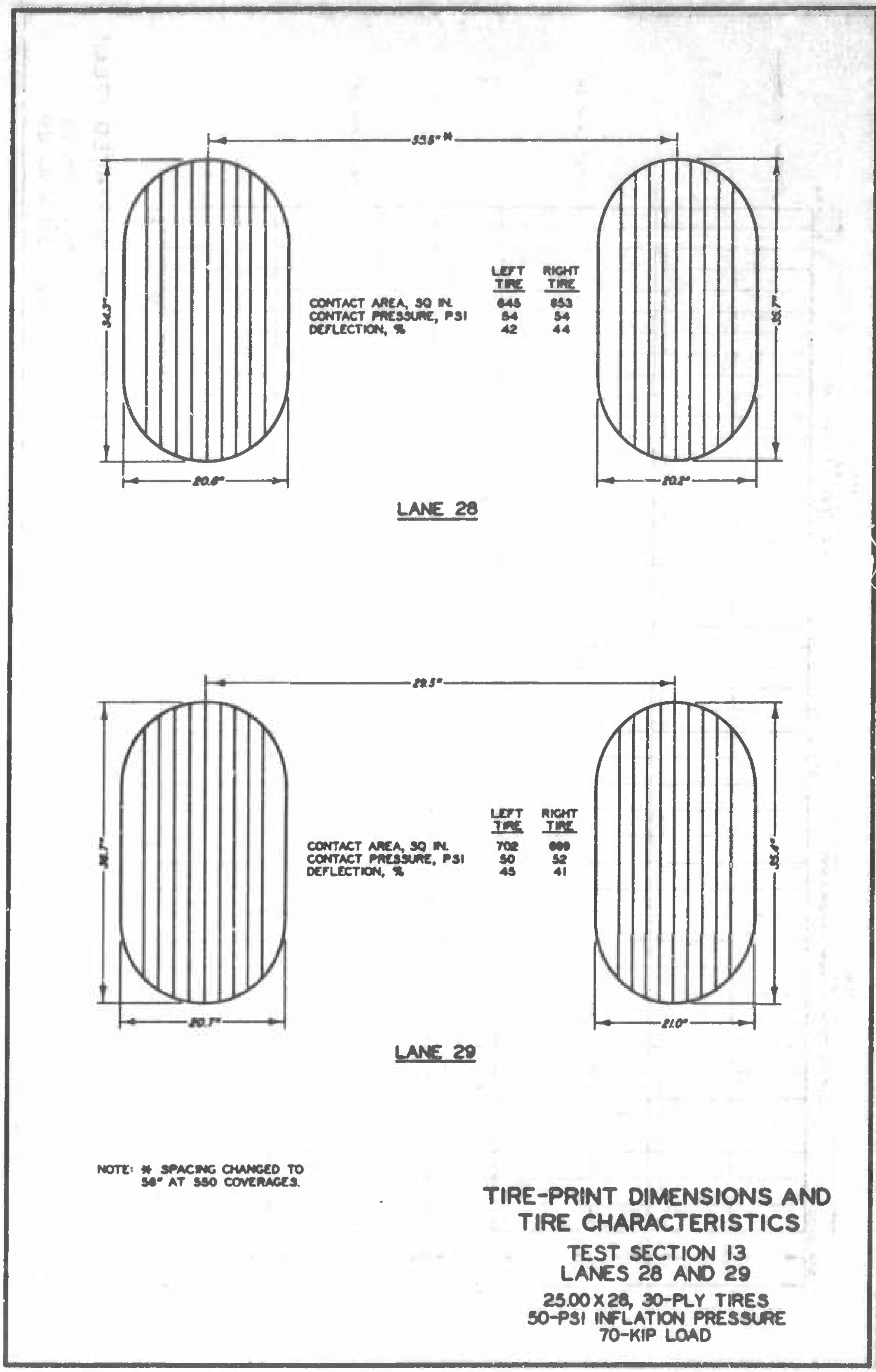
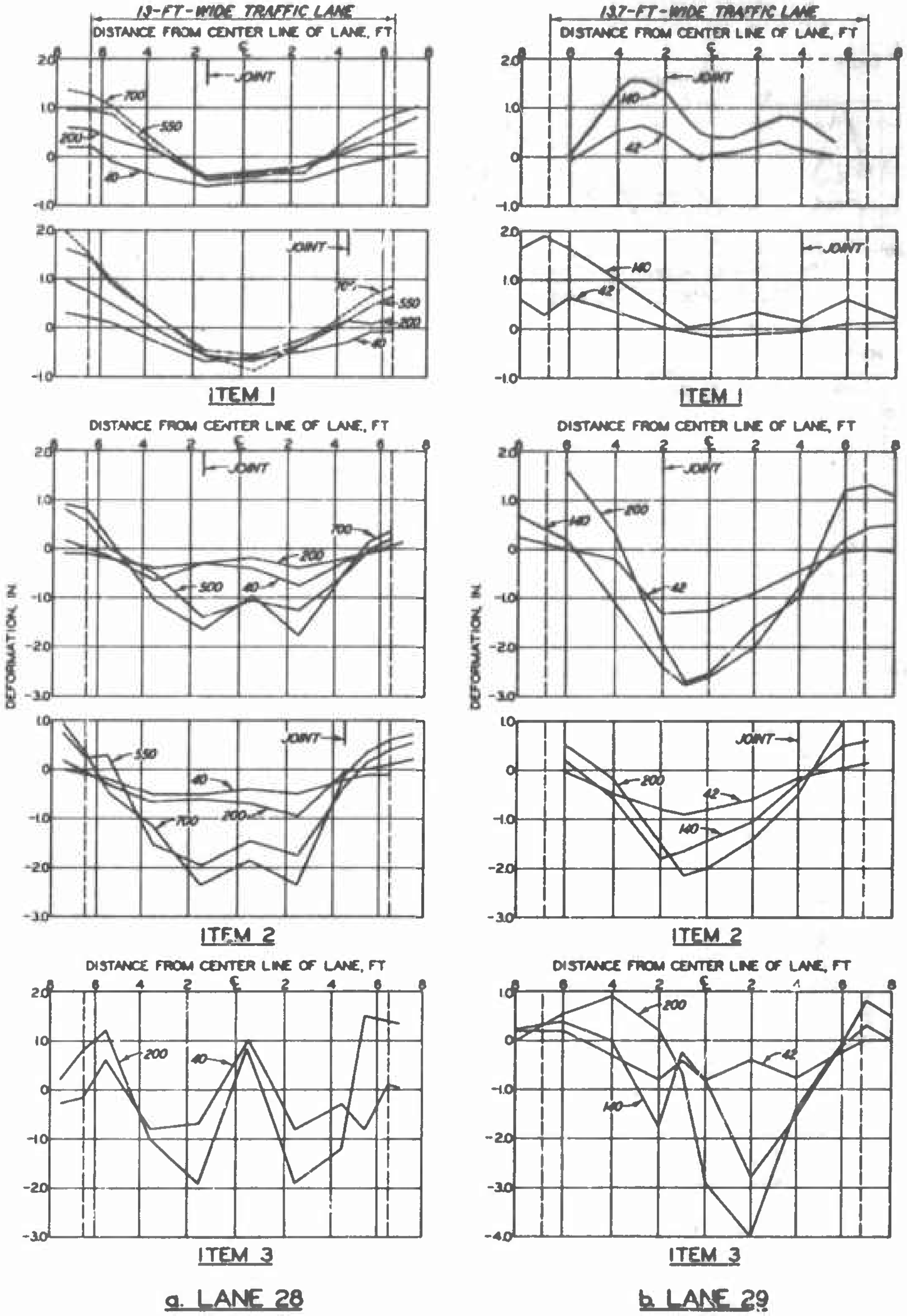

LAYOUT OF SURFACED ITEMS
TEST SECTION 13
LANES 28 AND 29
N
TEST LANE 28
TEST LANE 29
ITEM 1
40'
MODIFIED T11 ALUMINUM LANDING MAT
ITEM 2
42'
M8 STEEL LANDING MAT
STA 0+00
STA 0+40
STA 0+82
RUN NUMBER
1
5
10
15
19 20
25
30
35
40
44
13'
13'
5.3'
13.7'
8'
54'
5'
2'
4.7'
3'

Figure 16



20.6"
20.2"
34.3"
35.7"
LEFT TIRE
RIGHT TIRE
CONTACT AREA, SQ IN. 645 653
CONTACT PRESSURE, PSI 54 54
DEFLECTION, % 42 44
LANE 28
29.5"
20.7"
21.0"
35.4"
LEFT TIRE
RIGHT TIRE
CONTACT AREA, SQ IN. 702
CONTACT PRESSURE, PSI 50 52
DEFLECTION, % 45 41
LANE 29
NOTE: * SPACING CHANGED TO 58" AT 550 COVERAGES.
TIRE-PRINT DIMENSIONS AND TIRE CHARACTERISTICS
TEST SECTION 13
LANES 28 AND 29
25.00 X 28, 30-PLY TIRES
50-PSI INFLATION PRESSURE
70-KIP LOAD

Figure 17



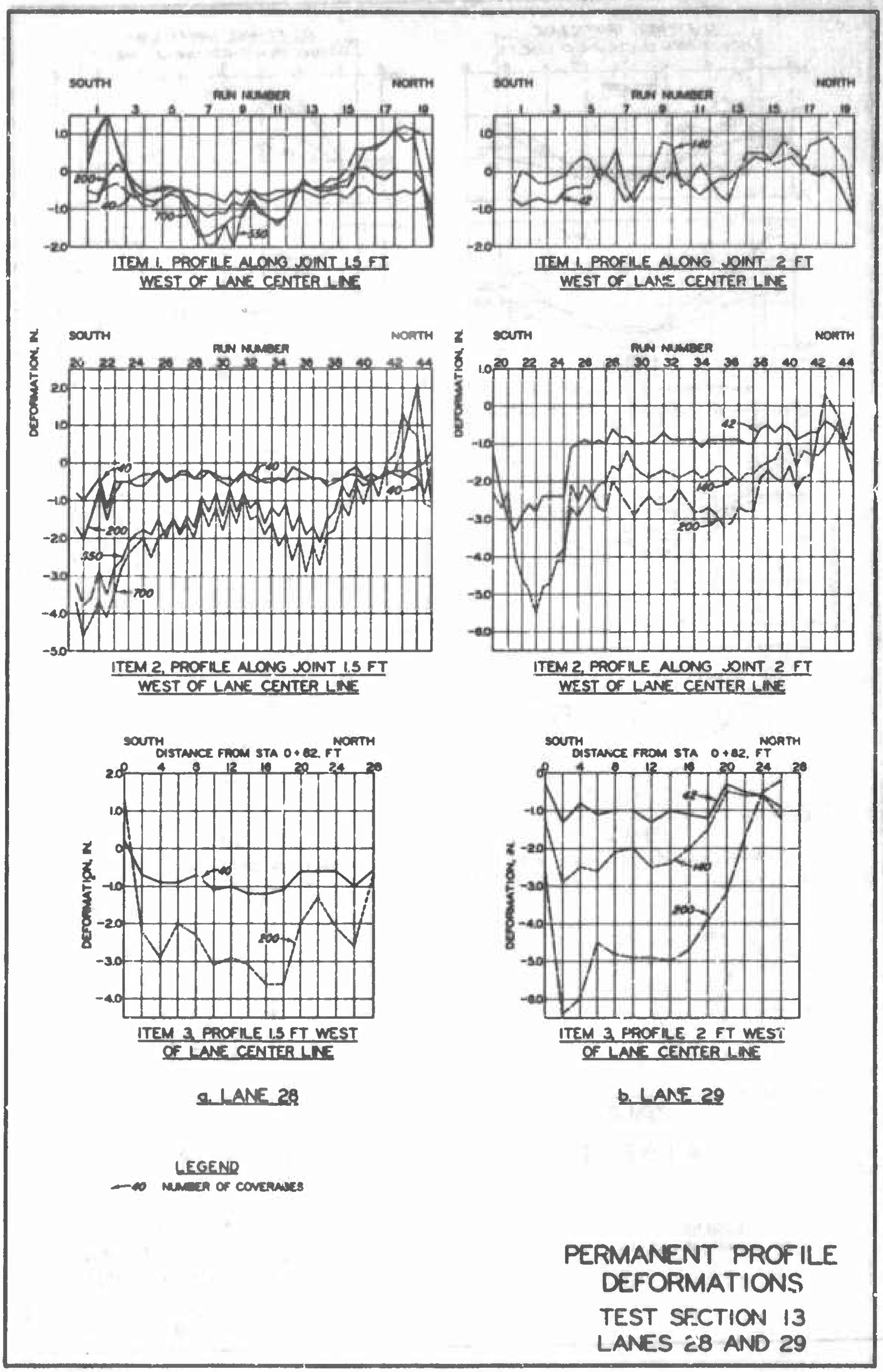
LEGEND

←200 NUMBER OF COVERAGES

AVERAGE CROSS-SECTIONAL DEFORMATIONS

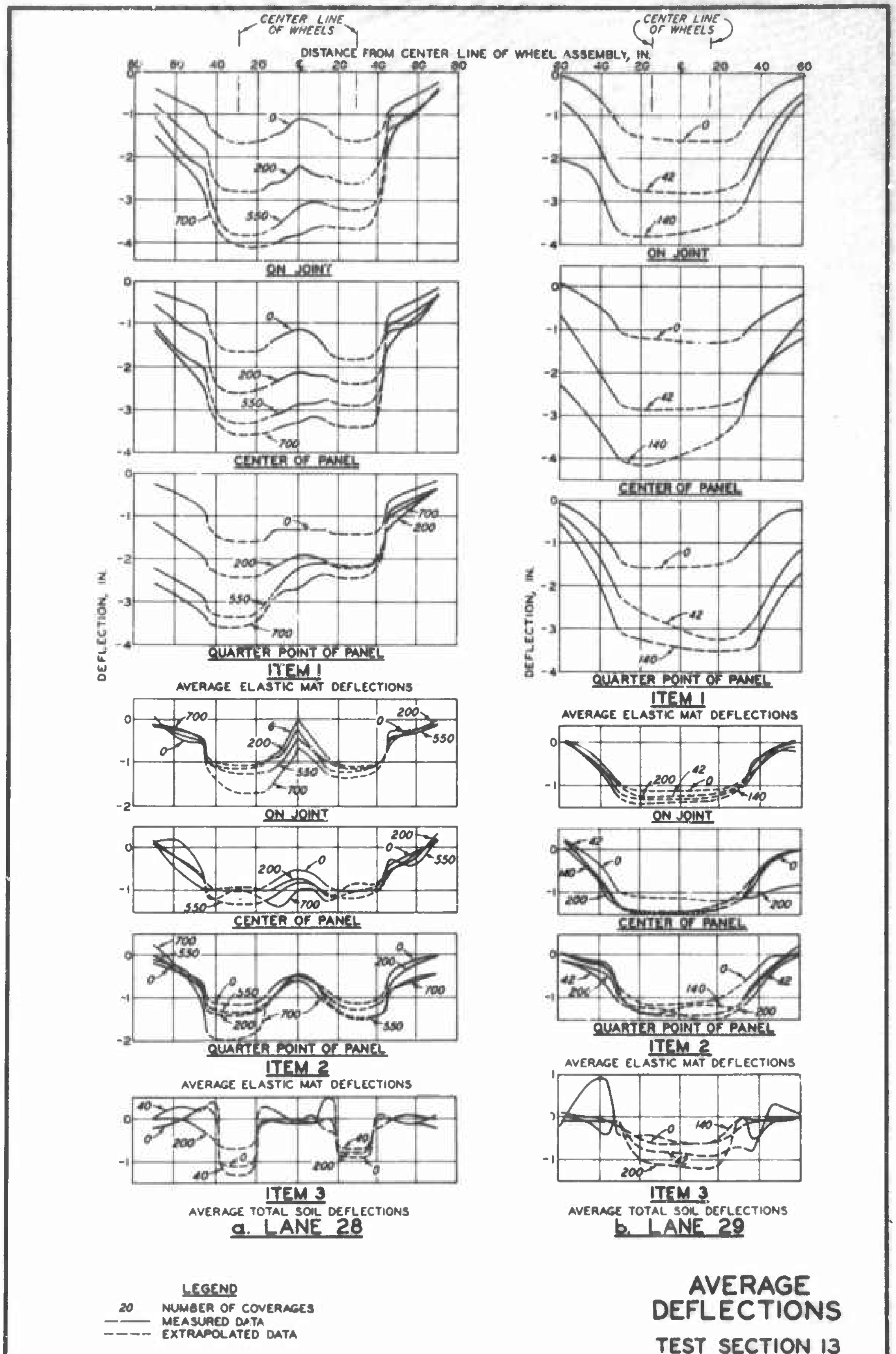
TEST SECTION 13
LANES 28 AND 29

Figure 18



SOUTH
RUN NUMBER
NORTH
ITEM 1, PROFILE ALONG JOINT 1.5 FT WEST OF LANE CENTER LINE
ITEM 1, PROFILE ALONG JOINT 2 FT WEST OF LANE CENTER LINE
DEFORMATION, IN.
ITEM 2, PROFILE ALONG JOINT 1.5 FT WEST OF LANE CENTER LINE
ITEM 2, PROFILE ALONG JOINT 2 FT WEST OF LANE CENTER LINE
DISTANCE FROM STA 0+82, FT
ITEM 3, PROFILE 1.5 FT WEST OF LANE CENTER LINE
ITEM 3, PROFILE 2 FT WEST OF LANE CENTER LINE
a. LANE 28
b. LANE 29
LEGEND
40 NUMBER OF COVERAGES
PERMANENT PROFILE DEFORMATIONS
TEST SECTION 13
LANES 28 AND 29

Figure 19



AVERAGE DEFLECTIONS

TEST SECTION 13
LANES 28 AND 29

Figure 20

UNCLASSIFIED

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	2b. GROUP	
3. REPORT TITLE Aircraft Ground-Flotation Investigation Part XIII Data Report on Test Section 13		
4. DESCRIPTIVE NOTES (Type of report and inclusive dates) Final Technical Report		
5. AUTHOR(S) (Last name, first name, initial) Watkins, J. E. Hammitt, G. M., II		
6. REPORT DATE Sept 1966	7a. TOTAL NO. OF PAGES 27	7b. NO. OF REFS
8a. CONTRACT OR GRANT NO. MIPR AS-4-177	9a. ORIGINATOR'S REPORT NUMBER(S) AFFDL-TR-66-43, Part XIII	
b. PROJECT NO. 410A		
c.	9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report) None	
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13. ABSTRACT

This data report describes the results of work undertaken as part of an overall program to develop ground-flotation criteria for the C-5A aircraft.

DD FORM 1 JAN 64 1473

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Security Classification

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
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Rolling Resistance						
Rear Area Airfields						
Support Area Airfields						
Forward Area Airfields						
Vehicle Mobility						

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